

TITLE OF THE INVENTION

METHOD AND APPARATUS FOR CORRECTING SCANNING ERROR IN FLATBED SCANNER

CLAIM OF PRIORITY

[0001] This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C. § 119 from my application for *METHOD FOR CORRECTING SCANNING ERROR IN THE FLATBED SCANNER AND APPARATUS THEREOF* filed with the Korean Industrial Property Office on 6 July 2001 and there duly assigned Serial No. 40481/2001.

BACKGROUND OF THE INVENTION

Technical Field

[0002] The present invention relates to a flatbed scanner, and more particularly, to a method and apparatus for correcting a scanning error due to a deviation in the position of a charge-coupled device (CCD) module of a flatbed scanner.

Description of the Related Art

[0003] In a flatbed scanner, a CCD module emits light onto a transparent glass of a flatbed, focuses light reflected from a document that sits on the transparent glass, and reads the image of the document. To accomplish this, upon application of power to the flatbed scanner, the CCD module moves until a home position is detected. If the home position is detected, the CCD module moves

1 to a white shading plate in order to set white shading. Then, if the white shading is set through a
2 white shading plate, the CCD module moves to a scan start line of the transparent glass in order to
3 start an actual scanning operation.

4 [0004] A conventional flatbed scanner moves the CCD module to the home position using a home
5 position sensor provided therein. The flatbed scanner controls other movements of the CCD module,
6 *i.e.*, the movements of the CCD module from the home position to the white shading plate and from
7 the white shading plate to the scan start line, by using values which are pre-computed considering
8 the distances the CCD module is to be moved.

9 [0005] However, since the pre-computed values do not vary depending on the type of flatbed
10 scanner but are determined from a standard flatbed scanner, any deviations in the movement of the
11 CCD module may cause distortions in a resultant image.

12 [0006] For example, if deviations in the position of the CCD module occur such that the scan start
13 line is not detected exactly, Y-registration may occur such that a vertical line, which does not exist
14 in a real image, exists at the top of the scanned image. Furthermore, since a conventional flatbed
15 scanner operates to set the position of a first pixel on a document at a predetermined value, for
16 example, 130 pixels, if an image is scanned such that the first pixel is positioned in front of the
17 predetermined value due to a deviation in the position of the CCD module, the content of the
18 document in front of the predetermined value is shielded by a scan-upper to produce a vertical line
19 that does not exist in the real image on the left portion of the document.

20 [0007] Furthermore, a conventional flatbed scanner does not consider a skew that results when

1 the CCD module is slanted to the right or left, thereby obtaining an unexpected scanned image due
2 to skew of CCD module.

3 [0008] In addition, a conventional flatbed scanner does not consider the right and left
4 magnifications of a scanning image, thereby failing to obtain a scanning image having an accurate
5 scan rate due to a scanning deviation of a CCD module. For example, even if an image having a
6 scan rate of 100% is desired, an image having a scan rate of 105% or 95% may result.

SUMMARY OF THE INVENTION

7 [0009] It is therefore an object of the present invention to provide a method and apparatus for
8 correcting a scanning error in a flatbed scanner, which can reduce a scanning error due to deviations
9 in the position of a CCD module as much as possible by determining a scanning position for each
10 flatbed scanner.

11 [0010] It is another object of the present invention to provide a method and apparatus for
12 correcting a scanning error in a flatbed scanner, which can reduce a scanning error due to deviations
13 in the position of a CCD module as much as possible by securing a scan region as wide as possible
14 in horizontal and vertical directions for each flatbed scanner.

15 [0011] It is still another object of the present invention to provide a method and apparatus for
16 correcting a scanning error in a flatbed scanner, which can reduce a scanning error due to scanning
17 deviations of a CCD module as much as possible by determining a scanning rate for each flatbed
18 scanner.

1 [0012] Accordingly, to achieve the above and other objects, the present invention provides an
2 apparatus for correcting a scanning error in a flatbed scanner. The apparatus preferably includes a
3 white shading plate having one black patch, a reading module for reading the white shading plate
4 and the black patch, and a controller that compares information about the black patch read by the
5 reading module with a predetermined reference value to correct the scanning error in the flatbed
6 scanner.

7 [0013] Preferably, the controller corrects the scanning error by using information about one or
8 more edge lines of the black patch read through the reading module and information about one or
9 more intervals thereof. The controller corrects a scan start line using the result of comparing a
10 predetermined reference value with the number of pixels corresponding to an interval by which the
11 reading module is moved from a top edge line of the black patch through the reading module to a
12 predetermined point.

13 [0014] Preferably, the controller sets a scan region based on the detection of a rightmost edge line
14 of the black patch through the reading module and a position at which a first pixel is read obtained
15 during reading of the white shading plate, thereby correcting a scanning error for the position at
16 which the first pixel is read. Alternatively, the controller may set a scan region based on the
17 detection of the top edge line and a bottom edge line of the black patch read through the reading
18 module and an interval by which the reading module is moved from the top edge line to the bottom
19 edge line. Also, the controller adjusts a scan rate based on predetermined right and left intervals with
20 respect to the center of the black patch read through the reading module.

1 [0015] The present invention also provides a method for correcting a scanning error in a flat
2 scanner in which a white shading plate has one black patch. The method preferably includes
3 detecting one or more information related to the black patch and an interval by which a reading
4 module is moved, based on information obtained by reading the black patch of the white shading
5 plate through the reading module, and correcting the scanning error according to the result of
6 comparing the information detected in the detection with a predetermined reference value.

BRIEF DESCRIPTION OF THE DRAWINGS

10 [0016] A more complete appreciation of this invention, and many of the attendant advantages
thereof, will be readily apparent as the same becomes better understood by reference to the following
detailed description when considered in conjunction with the accompanying drawings in which like
reference symbols indicate the same or similar components, wherein:

11 [0017] FIG. 1 is a conceptual view showing the operation of a flatbed scanner for explaining a
method for correcting a scanning error according to the present invention;

12 [0018] FIG. 2 is a block diagram of an apparatus for correcting a scanning error in a flatbed
scanner according to the present invention;

13 [0019] FIG. 3 is a flowchart of a method for correcting a scanning error in a flatbed scanner
according to the present invention; and

14 [0020] FIG. 4 is a detailed flowchart of a method for correcting a scanning error in a flatbed
scanner according to the present invention.

1 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

2 [0021] Turning now to the drawings, referring to FIG. 1, a flatbed scanner 100 includes a charge-
3 coupled device (CCD) module 101, a white shading plate 103 having one black patch 104 according
4 to the present invention, and a transparent glass 114. The black patch 104 has the shape of a
5 character "E" slanted downward at an angle of 90°. It is possible to form a black patch having a
6 shape similar to that of the black patch 104 in the white shading plate 103. That is, any pattern that
7 can be divided by its center into two equal patterns may be used as the black patch 104 of the white
8 shading plate 103.

9 [0022] Before or after white shading through the white shading plate 103, a scan position and a
10 scan region are determined by detecting edge lines 105, 106, 107, 108, 109, 110, 111, and 112 of the
11 black patch 104 and the number of pixels in particular intervals a, b, c, d, e, f, g, h, i, and j of the
12 black patch 104. Furthermore, the right and left magnifications of a scanned image is corrected by
13 considering the number of pixels in the intervals f and g, or d, f, g, and j. Here, the magnification
14 refers to a scan rate of a document.

15 [0023] A scan start line 115 is included on the transparent glass 114, and reference numeral 116
16 denotes a region at which a first pixel exists.

17 [0024] FIG. 2 is a block diagram of an apparatus for correcting a scanning error due to position
18 or scanning deviation of a CCD module using a black patch of a white shading plate in a flatbed
19 scanner as described above. Referring to FIG. 2, the scanning error correcting apparatus according
20 to the present invention includes a transparent glass 201, a charge-coupled device (CCD) module

1 202, a white shading plate 203, a buffer 204, a memory 205, and a controller 206.

2 [0025] The transparent glass 201 is provided on a flatbed of the flatbed scanner for placing a
3 document to be scanned. The CCD module 202, which is a reading module for reading an image,
4 is configured in the same manner as a CCD module of a conventional flatbed scanner. The white
5 shading plate 203 is used for setting a white reference level. Although the white shading plate 203
6 is configured in a way akin to that of a conventional flatbed scanner, the difference is that the white
7 shading plate 203 in the present invention includes the black patch 104 having the shape shown in
FIG. 1. Thus, when reading an image from the white shading plate, the CCD module 202 performs
a scanning error correction according to the present invention using the result of the particular
intervals of the black patch 104 detected by the CCD module 202.

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[0026] The buffer 204 stores an image read by the CCD module 202 from the document that sits
on the transparent glass 201. The memory 205 stores reference values required for scanning error
correction according to the present invention. That is, the memory 205 stores condition information
about edge lines and the particular intervals of the black patch 104, which will be required when
correcting a scanning error. The condition information stored in the memory 205 is read by the
controller 206. The condition information may also be stored in the controller 206. The controller
206 compares the condition information stored in the memory 205 with information about the edge
lines and the particular intervals of the black patch 104 of the white shading plate 203 detected
through the CCD module 202, and determines a scanning region and a scanning position, thereby
correcting a scanning error resulting from deviations in the position or scanning of the CCD module

1 202. The operation of the controller 206 for correcting a scanning error will be described below in
2 greater detail with reference to FIG. 4.

3 [0027] FIG. 3 is a flowchart showing scanning error correction method according to the present
4 invention. The flowchart of FIG. 3 will now be described with reference to the apparatus of FIG.
5 2.

6 [0028] When power is applied to the flatbed scanner, the controller 206 instructs the CCD module
7 202 to move to a home position 102 in step 301. If it is determined that the CCD module 202 reaches
8 the home position in step 302, the CCD module 202 performs a warm-up for a predetermined time
9 in step 303. The way of determining whether the CCD module 202 reaches the home position 102
10 is the same as that of a conventional flatbed scanner.

11 [0029] If the warm-up of the CCD module 202 is completed, in step 304, the controller 206 moves
12 the CCD module 202 to the white shading plate 203 and performs white shading in the same manner
13 as in a conventional flatbed scanner. In step 305, the controller 206 compares the results of reading
14 the black patch 104 of the white shading plate 203 through the CCD module 202 with the reference
15 values stored in the memory 205 and determines a scanning region, a scanning position, and a
16 scanning rate for the transparent glass 201. Thus, a scanning error resulting from deviations in
17 position or scanning of the CCD module 202 is corrected. The operation shown in step 305 will be
18 described below in greater detail with reference to FIG. 4. In step 306, a routine for performing
19 actual scanning through the transparent glass 202 based on the scanning region and scanning position
20 is executed.

1 [0030] Although it has been shown in FIG. 3 that the scanning region, the scanning position, and
2 the scanning rate are determined through the black patch 104 after white shading, white shading may
3 be performed after determining the scanning region, the scanning position, and the scanning rate
4 through the black patch 104.

5 [0031] FIG. 4 is a detailed flowchart of a method for correcting a scanning error due to deviations
6 in the position or scanning of the CCD module 202 by comparing the result of reading the black
7 patch 104 of the white shading plate 203 through the CCD module 202 with reference values stored
8 in the memory 205. In particular, FIG. 4 shows methods for correcting an error for the first pixel
9 at the region 116 of FIG. 1 and a skew and a magnification error of the CCD module 202.

10 [0032] Steps 401-406 of the flowchart are steps of a process for correcting a scan start line. In
11 step 401, when the CCD module 202 reads an image from the white shading plate 203, the controller
12 206 checks whether the edge line 105 of the black patch 104 is detected. The edge line 105 is a top
13 edge line of the black patch 104. The edge line 105 is the first line in which a black pixel is detected
14 as a result of reading the image from the white shading plate 203 through the CCD module 202.

15 [0033] If the edge line 105 has been detected, in step 402, the controller 206 checks the presence
16 of black and white pixels in the white shading plate 203 through binary data output from the CCD
17 module 202 while moving the CCD module 202. If the intervals 'f' and 'g' of the black patch 104
18 are all detected to be white pixels in step 403, in step 404, the controller 206 extracts the number of
19 pixels corresponding to an interval by which the CCD module is moved vertically from the point at
20 which the edge line 105 is detected to the point at which both intervals 'f' and 'g' are detected to

1 white pixels. If the intervals 'f' and 'g' of the black patch 104 are not detected in step 403, the
2 controller 206 returns the process to step 402.

3 [0034] In step 405, the controller 206 compares the number of pixels extracted with a reference
4 value to detect a difference between the number of pixels extracted and the reference value. The
5 reference value, which is stored the memory 205, is the number of pixels corresponding to the
6 intervals 'e' and 'h' of FIG. 1, that is, an interval $e+h$. In step 406, the controller 206 moves the
7 CCD module 202 by an amount corresponding to the detected difference so as to start scanning. For
example, if the number of pixels corresponding to the interval $e+h$ is 216 pixel, the controller 206
moves the CCD module 202 by the number of pixels obtained as a result of subtracting from 216
the number of pixels corresponding to the distance by which the CCD module 202 is moved
vertically to the point at which the intervals 'f' and 'g' are detected, thereby correcting a scan start
line.

1 [0035] As described in steps 401-406, the scan start line is corrected by using the distance by
2 which the CCD module 202 is moved vertically from the point at which the edge line 105 is detected
3 to the point at which the intervals 'f' and 'g' are detected. However, the scan start line may be
4 corrected by a vertical movement distance of the CCD module 202 from the point where the edge
5 line 105 is detected to the point where the edge lines 110, 111, and 112 are detected.

6 [0036] Steps 407-412 of the flowchart are steps of a process for correcting a first pixel. In step
7 407, while the CCD module 202 reads an image from the white shading plate 203, the controller 206
8 checks through binary data output from the CCD module 202 whether the edge line 106 of the black

1 patch 104 is detected. The edge line 106 is the rightmost edge line of the black patch 104.

2 [0037] If the edge line 106 is detected in step 407, in step 408, the controller 206 checks whether
3 a first pixel is read while reading of the white shading plate 203 is performed. If the first pixel has
4 been read, in step 409, the controller 206 detects the number of pixels corresponding to a difference
5 between a position where the first pixel has been read and the point where the edge line 106 has been
6 detected.

7 [0038] In step 410, the controller 206 compares the number of pixels detected with a reference
8 value. The reference value is the number of pixels corresponding to the interval ‘b’ of FIG. 1. That
9 is, the reference value is the number of pixels corresponding to an interval from the edge line 106
10 to the point set by the interval ‘b’. If the number of pixels detected is greater than the reference
11 value as a result of comparison, the position where the first pixel is read exists in the interval ‘a’ of
12 FIG. 1, and a black line may be produced in a vertical direction on a scanned image due to a scan-
13 upper. Thus, the controller 206 sets a scan region such that the first pixel is read at a point separated
14 from the line 106 by the number of pixels corresponding to the reference value.

15 [0039] Conversely, if the reference is greater than the number of pixels detected, the position
16 where the first pixel is read exists in the interval ‘b’ of FIG. 1. Thus, in step 412, the controller 206
17 sets a scan region from a point at which the first pixel read by the CCD module 202 is positioned.

18 [0040] For example, if the reference value is 192 pixels, the position of the read first pixel is
19 greater than 192 pixel, in step 411, the controller 206 sets a scan region beginning with a point (the
20 point including the entire interval ‘b’ of FIG. 1) separated to the right in a horizontal direction from

1 the edge line 106 by 192 pixels. However, if the position of the read first pixel is not greater than
2 192 pixels (if the position is within the interval 'b' of FIG. 1), in step 412, the scan region is set from
3 the point where the first pixel is read.

4 [0041] By performing steps 407-412 in this way, the flatbed scanner sets a scan region in which
5 an error for a first pixel has been corrected.

6 [0042] Steps 413-418 of the flowchart are steps of a process for correcting a skew. In step 413,
7 when the CCD module 202 reads an image from the white shading plate 203, the controller 206
8 makes the CCD module 202 move in a vertical direction from the edge line 105 by a distance
9 corresponding to the interval 'e'. In step 414, the controller 206 detects the edge lines 110, 111, and
10 112 of the black patch 104 through binary data transmitted from the CCD module 202. The edge
11 lines 110, 111, and 112 are bottom edge lines of the black patch. The bottom edge lines 110, 111,
12 and 112 are detected in the same manner as described above by checking whether black or white
13 pixels are read by the CCD module 202.

14 [0043] In step 415, the controller 206 checks whether all of the edge lines 110, 111, and 112 are
15 white pixels through the binary data transmitted from the CCD module 202. If all of the edge lines
16 110, 111, and 112 are white pixels, in step 416, the controller 206 checks the number of pixels
17 corresponding to an interval by which the CCD module 202 is moved in a vertical direction from
18 the edge line 105. In step 417, the controller 206 compares the number of pixels checked with a
19 reference value to detect a difference between the numbers of pixels checked and the reference value.
20 The reference value, which is stored in the memory 205, is the number of pixels corresponding to

1 the interval 'e' of FIG. 1. In step 418, if the difference is detected, the controller 206 sets a scan
2 region such that the skew is corrected using the detected difference.

3 [0044] That is, if the skew is zero, white pixels are detected in all of the edge lines 110, 111, and
4 112. However, if the skew occurs, a black pixel may be detected in the edge lines 110 and 111 and
5 a white pixel may be detected in the edge line 112 or vice versa. Alternatively, a black pixel may
6 be detected in the edge line 110 and a white pixel may be detected in the edge lines 111 and 112.
7 If the skew occurs in this way, a white pixel is not simultaneously detected in all of the edge lines
8 110, 111, and 112.

9 [0045] Thus, if the skew does not exist, since a point at which a white pixel is detected in all of
10 the edge lines 110, 111, and 112 is a point having the number of pixels corresponding to the
11 reference value used in step 417, the difference detected in step 417 is 'zero', and thus it is
12 unnecessary to set a scan region considering a skew in step 418.

13 [0046] However, if a skew exists, a point at which a white pixel is detected in all of the edge lines
14 110, 111, and 112 is a point having the number of pixels which is greater than the reference value
15 used in step 417. Thus, the difference is detected in step 417. For example, if the number of pixels
16 corresponding to a distance by which the CCD module 202 is moved in a vertical direction to the
17 point at which the edge lines 110, 111, and 112 are all white pixels is 168 and the number of pixels
18 corresponding to the interval 'e' is 144, the difference detected in step 417 is 24 pixels. Thus, the
19 controller 206 needs to set a scan region such that the skew corresponding to 24 pixels is corrected.

20 [0047] In order to correct a skew, if the detected difference is 24 pixels, a scan region is set by

1 detecting right and left skew range with respect to the center of the black patch 104 using 12 which
2 is obtained by dividing 24 by 2 (24/2). That is, 12 pixels correspond to a right and left skew range
3 of 0.5 mm since 24 pixels are allocated per 1 mm. Thus, the controller 206 sets a scan region so that
4 a scan start line is moved by 7 mm (6 mm +0.5 mm×2), thereby correcting a skew.

5 **[0048]** Steps 419-422 of the flowchart are steps of a process for adjusting a scan rate so that a
6 magnification error of the flatbed scanner is corrected. In step 419, when the CCD module 202 reads
7 an image from the white shading plate 203, the controller 206 detects the number of pixels from the
8 intervals ‘f’ and ‘g’ of FIG. 1. In step 420, the controller compares the number of pixels of the
9 interval ‘f’ and the number of pixels of the interval ‘g’ detected in step 419 with corresponding
10 reference values and detects differences between the number of pixels of the interval ‘f’ and the
11 number of pixels of the interval ‘g’ detected in step 419 with corresponding reference values. The
12 reference values corresponding to the number of pixels in the intervals ‘f’ and ‘g’ are preset for the
13 intervals ‘f’ and ‘g’ and stored in the memory 205. In step 421, the size of a current scan region over
14 the entire scan region is detected based on the detected differences. For example, if the number of
15 pixels in the interval ‘f’ is 2064, and its reference value stored in the memory 205 is 2040, and if the
16 number of pixels in the interval ‘g’ is 2064 and its reference value is 2040, additional 24 pixels are
17 read to the right and left of the scan region. Thus, if an interval of 170 mm (millimeters) is obtained
18 by subtracting the widths of the edge lines 110, 111, and 112 from the interval ‘c’ of FIG. 1 in the
19 entire scan region, the scan region is read by an additional 2 mm. This is because 24 pixels are
20 allocated per 1 mm and 24 pixels are read further in each of the intervals ‘f’ and ‘g’. Therefore, if

1 the entire scan region is 216 mm and each of the intervals 'f' and 'g' are recognized as 86 mm, the
2 scan region is read by an additional 2.54 mm ($=216 \times ((86/85)-1)$). Using 2.54 mm and the size (216
3 mm) of entire scan region, the size of a current scan region is detected to be 101%
4 ($=(216+2.54)/216$).

5 [0049] In step 422, if the size of the current scan region is detected, the controller 206 adjusts a
6 scan rate using the detected scan size. That is, as shown in step 421, 101% scanning is performed
7 when the scan rate is 100%. Thus, a 100% scanned image can be obtained by changing the scan rate
to about 99% ($=(100/101) \times 100$).

8 [0050] Although the above magnification error correction has been made by using pixels in the
9 intervals 'f' and 'g' of FIG. 1, this correction may be made by further considering the intervals 'j'
10 and 'd' of FIG. 1. In order to further consider the intervals 'j' and 'd', the controller 206 uses
11 information about the edge lines 107 and 106, which are lines furthest to the left and right,
12 respectively. The right and left intervals of the black patch 104 are considered in this way to
13 determine the right and left edges of the scan region.

14 [0051] FIG. 4 shows the correction processes performed in parallel based on binary data
15 transmitted from the CCD module 202. Alternatively, all edge lines and the number of pixels in all
16 intervals thereof required for the above correction based on the binary data transmitted through the
17 CCD module 202 are firstly detected, and then corresponding reference values stored in the memory
18 205 are compared with information about the detected black patch 104 in order to obtain the
19 correction result in a specified order. A scan region, a scan position, and a scan rate are then
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1 determined based on the obtained correction result to control the operation of the CCD module 202
2 or the output range of a scanned image stored in the buffer 204.

3 [0052] As described above, according to the present invention, one black patch is provided in a
4 white shading plate of a flatbed scanner, the correction of a corresponding scanning error is
5 determined by detecting each edge line of black patch and the number of pixels in each interval
6 thereof and comparing the detected values with corresponding reference values, and a scanning
7 region, a scanning position, and a scan rate are determined for each flatbed scanner. Thus, the
8 present invention can secure a scanning region in horizontal and vertical directions as wide as
9 possible for each flatbed scanner and prevents occurrences of error in a scanned image due to
10 position deviations in a CCD module. Furthermore, the present invention provides a scanned image
11 accurately having a desired scan rate by comparing right and left sizes and the entire scan size for
12 a currently scanned region detected by the black patch.

13 [0053] While the invention has been particularly shown and described with reference to the
14 preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing
15 and other changes in form and details may be made therein without departing from the spirit and
16 scope of the invention.